

AD-A068 951 ARMY TEST AND EVALUATION COMMAND ABERDEEN PROVING GRO--ETC F/G 1/3  
INTERNAL/EXTERNAL LIGHTING (AVIATION MATERIEL).(U)  
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Lighting Controls      Instrument decals, switches      Chromaticity  
Lighting Balance      Night Vision Lighting System Compatibility  
Light Reflectors/Glare      Ausiliary Lights      Position Lights  
Illumination Levels      Navigation Lights      Anti-collision Lights  
Caution, Warning Lights      Operational Performance      Landing & Taxiing Lights

Procedures are prescribed for determining the functional characteristics of an internal/external light or lighting system developed for US Army aircraft.

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US ARMY TEST AND EVALUATION COMMAND  
TEST OPERATIONS PROCEDURES

DRSTE-RP-702-106

\*Test Operations Procedures 7-3-527

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AD No.

INTERNAL/EXTERNAL LIGHTING  
AVIATION MATERIEL

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1. SCOPE. This TOP establishes the procedure to conduct a developmental test of an internal and/or external lighting system as well as illumination test of a single or multiple instruments set or any other special purpose light or lights associated with the aircraft operational capability or crew performance, including troop and cargo compartment lighting. The aircraft light or lighting system will be operated during all applicable aircraft operational phases and assessed under all applicable atmospheric and climatic conditions representative of the operational environment the aircraft is expected to see within its operational theater. The primary objectives of this TOP are: (1) to determine if the designated light or lighting system performs its intended function in accordance with the requirements presented in the applicable approved documents; Letter of Requirement (LR), Letter of Agreement (LOA), Required Operational Characteristics (ROC), etc., as reflected through the detailed Test Design Plan (TDP); (2) to establish any detrimental or compromising side

\*This TOP supersedes MTP 7-3-527, 12 March 1971.

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effects; (3) to insure human factors criteria have been met; and (4) to determine if the designated light or lighting system conforms to the applicable military specifications and/or standards as well as system specifications.

2. FACILITIES, EQUIPMENT AND INSTRUMENTATION. Developmental testing of an aircraft light or lighting system will be accomplished within the aircraft environment of the designated aircraft type and configuration for which the light/lighting system was developed, and in accordance with all Army maintenance and operational scenarios established for the designated aircraft and light/lighting system. The facilities, instrumentation and support equipment required to support the developmental test should be defined in the Test Design Plan or the Maintenance Support Plan (MSP); however, if this data is not available the following facility characteristics, support and instrumentation requirements should be addressed as a minimum to support the evaluation of all developmental criteria presented in the appropriate materiel documents (LR, LOA, ROC, etc.).

### 2.1 Facility.

#### CHARACTERISTICS

Appropriate Operational Airfield(s)

Maintenance

Airspace

#### MINIMUM REQUIREMENTS

As required to experience meteorological effects on the light/lighting systems.

As required to support aircraft test materiel.

As appropriate to conduct materiel test.

### 2.2 Instrumentation.

Photometer

$10^{-5}$  to  $10^7$  ft - Lambert  $\pm 4\%R$   
 $(3.0 \times 10^{-4}$  to  $3.0 \times 10^7$  cd/m<sup>2</sup>  $\pm 4\%R$ )  
 X100 attenuator to 30,000 ft -  
 Lambert  $\pm 5\%R$

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CHARACTERISTICS

MINIMUM REQUIREMENTS

Spot Brightness Meter

1 to  $10^8$  ft - Lambert + 5%R  
(0.3 to  $3.43 \times 10^8$  cd/m<sup>2</sup> + 5%R)

Spectro-Radiometer

Chromaticity requirements (350 -  
700 nanometers wave length range)

2.3 Support Requirements.

2.3.1 Equipment.

Maintenance support

Standard Army tool set.

Photographic

Color camera.

Appropriate aircraft and air-  
craft support equipment

As required.

2.3.2 Personnel.

Appropriate number with proper  
MOS and special training.

As required.

Test personnel equipment

Applicable flight gear.

2.4 References.

a. Army Regulation 385-16, Safety: Safety for Systems, Associated Subsystems, and Equipment.

b. Army Regulation 750-6, Maintenance of Supplies and Equipment: Maintenance Support Planning.

c. DARCOM Regulation 700-38, w/TECOM Supplement 1 and USAADTA Supplement 1, Test and Evaluation -- Incidents Disclosed During Materiel Testing.

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d. TECOM Regulation 70-24, Research and Development: Documenting Test Plans and Reports.

e. TECOM Regulation 108-1, Photographic Coverage. (As implemented by USAADTA Memo 108-1).

f. AMC Regulation 385-12, Life Cycle Verification of Materiel Safety, and TECOM Supplement 1 thereto.

g. TECOM Regulation 700-1, Quality Assurance: Value Engineering.

h. TECOM Regulation 750-15, Maintenance of Supplies and Equipment: Maintenance Evaluation During Testing.

i. Letter Requirement, TRADOC ACN 32840, Improved Lighting Systems for Army Aircraft.

j. MIL-STD-129, Marking for Shipment and Storage.

k. MIL-STD-130, Identification Marking of US Military Property.

l. MIL-STD-411, Aircrew Station Visual Signals.

m. MIL-STD-882, System Safety Program Requirements.

n. MIL-STD-1472, Human Engineering Design Criteria for Military Systems, Equipment and Facilities.

o. MIL-C-14806, Coating Reflection Reduction for Instrument Cover Glasses and Lighting Wedges.

p. MIL-C-25050, Color, Aeronautical Lights and Lighting Equipment, General Requirements for.

q. MIL-L-6484, Lights, Cockpit Utility, Aircraft General Specification for.

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- r. MIL-L-6503, Lighting Equipment, Aircraft, General Specification for, Installation of.
- s. MIL-L-8210, Light, Landing, Aircraft, Retractable, Type MA-2.
- t. MIL-L-18276, Lighting, Aircraft Interior, Installation of.
- u. MIL-L-25467, Lighting, Integral, Red, Aircraft Instrument, General Specification for.
- v. MIL-L-46159, Lacquer, Acrylic Low Reflective, Olive Drab, Amendment 3.
- w. MIL-L-56678, Lighting Equipment, Aircraft Instrument Panel, General Specification for Installation of.
- x. MIL-L-006730, Lighting Equipment; Exterior, Aircraft (General Requirements for).
- y. MIL-P-7788, Panel Information, Integrally Illuminated.
- z. MIL-S-38039, Systems, Illuminated, Warning, Caution and Advisory, General Specification for.
- aa. TOP 1-2-609, Instructional Material Adequacy Guide and Evaluation Standard (IMAGES).
- bb. TOP 1-2-610, Human Factors Engineering.
- cc. TOP 7-3-500, Physical Characteristics.
- dd. TOP 7-3-501, Personnel Training.
- ee. TOP 7-3-502, Installation Characteristics.
- ff. TOP 7-3-503, Arrival Inspection/Pre-Operational Inspection (Aviation Materiel).



gg. TOP 7-3-506, Safety.

hh. TOP 7-3-507, Maintenance (Maintainability/Availability).

ii. TOP 7-3-508, Reliability.

jj. TOP 7-3-509, Compatibility with Related Equipment.

kk. TOP 7-3-519, Photographic Coverage.

ll. Materiel Needs documents (LR, LOA, ROC).

mm. AR 70-62, Airworthiness Qualification of US Army Aircraft Systems.

3. PREPARATION FOR TEST. This section provides guidance for planning the developmental test. The planning phase should consummate with a detailed test plan. The test plan should establish the test methodology and provide the procedures for gathering and reducing data to accommodate each developmental test objective. The test plan should also identify all facility, equipment and support requirements including any specialized training requirements. The following test planning steps should be followed to insure a complete, thorough and cost effective developmental test.

3.1 Review. Review all pertinent data relative to the materiel development test.

a. Materiel Needs documents (LR, LOA, ROC).

b. Test Design Plan.

c. Applicable material available from the procuring agency or developer/contractor.

d. Pertinent reports on previous tests of like equipment.

e. Any other applicable sources of information (AR, TOPs, TM, etc.).

3.2 Test Objectives. Establish the test objectives. The test objectives should be available in the Test Design Plan; however, if this data is not available, review the Materiel Needs documents for developmental criteria and consider the following subtest objectives as appropriate as a minimum:



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a. Initial Inspection: Determine the condition and completeness of the internal/external lighting equipment in accordance with TOP 7-3-503.<sup>1</sup>

b. Physical Characteristics. Determine the physical characteristics of the developmental internal/external lighting equipment in accordance with TOP 7-3-500.<sup>2</sup>

c. Installation Characteristics. Determine the installation/removal characteristics of the internal/external lighting equipment in accordance with TOP 7-3-502.<sup>3</sup>

d. Compatibility. Determine if the developmental internal/external lighting equipment is compatible with each designated aircraft for which it was designed and compatible with all equipment on the intended aircraft during all applicable phases of aircraft operation, in accordance with TOP 7-3-509.<sup>4</sup> Electrical power requirements are of particular importance and should be accurately determined for each operational mode.

e. Operational Performance. Determine the adequacy and suitability of the developmental internal/external lighting equipment to perform its intended function in all applicable operational environment and flight modes the designated aircraft are expected to see within their operational theater. Follow the testing procedures as presented in paragraph 5, Performance Test, this TOP. Pay special attention to the human factors considerations to establish any detrimental or compromising side effects.

f. Reliability, Availability and Maintainability (RAM). Evaluate the RAM characteristics of the developmental internal/external lighting equipment in accordance with TOP 7-3-507<sup>5</sup> and TOP 7-3-508.

1. TOP 7-3-503, Arrival Inspection/Pre-Operational Inspection (Aviation Materiel).
2. TOP 7-3-500, Physical Characteristics.
3. TOP 7-3-502, Installation Characteristics (Aircraft Allied Equipment and Subsystems).
4. TOP 7-3-509, Compatibility with Related Equipment.
5. TOP 7-3-507, Maintenance (Maintainability/Availability).
6. TOP 7-3-508, Reliability.

g. Technical Manuals. Determine the adequacy of the technical manuals in accordance with TOP 1-2-609.

h. Personnel Training Requirements. Determine the scope of the pre-developmental test and field training required to operate and maintain the internal/external lighting equipment, in accordance with TOP 7-3-501.<sup>8</sup>

i. Human Factors. Determine if the test internal/external lighting equipment meets with acceptable human factors engineering, in accordance with TOP 1-2-610.<sup>9</sup>

j. Safety. Identify and evaluate hazardous characteristics of the test internal/external lighting equipment in accordance with TOP 7-3-506.<sup>10</sup>

3.3 Schedule. Prepare a detailed test timeline depicting each test associated event which must occur to insure availability of required support equipment, facilities, logistics and personnel to accomplish a comprehensive and cost effective test. An adequate timeline will show sufficient time periods allotted to accomplish each test objective insuring that an adequate amount of test data are taken to provide projected statistical confidences when the data is reduced. The following schedule items should be addressed as a minimum.

a. Facility. Schedule the applicable facility requirements presented in Section 2.1. Insure that the glare effects of rain, fog, snow and sleeting conditions are planned as applicable. Such conditions are particularly aggravated during night and/or IMC flight conditions.

b. Equipment and Support. Schedule the applicable instrumentation, equipment and support requirements presented in Sections 2.2 and 2.3.

c. Logistics. Schedule logistics requirements including ground handling equipment, administrative transportation of both personnel and equipment, aircraft fueling and servicing accommodations.

7. TOP 1-2-609, Instructional Material Adequacy Guide and Evaluation Standard (IMAGES).

8. TOP 7-3-501, Personnel Training.

9. TOP 1-2-610, Human Factors Engineering.

10. TOP 7-3-506, Safety.

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3.4 Plan of Test.<sup>11</sup> Develop a detailed test plan in accordance with TECOM Regulation 70-24. This test plan will provide the test procedures to be followed and the test data collection requirements to satisfy the test objectives.

3.5 Safety. Review the developer's safety statement to determine adequacy of content, and need for changes to the detailed test plan. Obtain any air worthiness approval for major modifications installed on aircraft (reference mm). Take appropriate steps (training, SOP's, checklists, etc) to prevent accidents or injuries throughout the test (see reference gg). Throughout the test, assess the degree to which the test item incorporates safety in design to prevent operator or maintainer injury and damage to the equipment. Assess the adequacy of safety instructions, warnings and cautionary notes in equipment manuals and labels affixed to equipment. 12, 13

3.6 Environmental Impact. Determine if there are any environmental considerations. If environmental hazards exist, develop procedures or outline precautions to be observed to protect the environment.

3.7 Human Factors Engineering. Make plans to assess the degree to which human factors engineering regarding operator safety performance and effectiveness has been designed into the developmental lighting equipment when operated and maintained by<sup>14</sup> qualified personnel in the operational environment. See TOP 1-2-610, dated 20 December 1977.

3.8 Security. Security safeguards for the United States Government and for the security of the proprietary rights of the test materiel developer must be considered early in the test planning stage. The following steps must be taken:

a. Consult the primary test agency security representative for security guidance. Coordinate with security personnel of other test support agencies and industry as appropriate.

11. TECOM Regulation 70-24, Research and Development: Documenting Test Plans and Reports.

12. TOP 7-3-506, Safety (Aviation Materiel).

13. AMC Regulation 385-12, Life Cycle Verification of Materiel Safety, and TECOM Suppl 1 thereto.

14. TOP 1-2-610, Human Factors Engineering.



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b. Take appropriate security measures throughout the test to safeguard intra-industry proprietary and classified material and to safeguard the security of government property.

c. See TOP 7-3-530, Vulnerability and Security (Aviation Materiel).<sup>15</sup>

4. TEST CONTROLS. The internal/external lighting equipment test will be conducted and test data will be recorded in strict compliance with the test design plan. If specific directions are not available, the following guidelines will prevail:

- a. Measurements will be reduced to universal metric and English units.
- b. Numerical observations will be rounded up to the nearest tenth.
- c. Time will be reported to the nearest hundredth of an hour.
- d. Physical characteristics will be accomplished and recorded in compliance with TOP 7-3-500.<sup>16</sup>
- e. Instrumentation and equipment will be properly calibrated and have a current calibration certificate.
- f. All tests will be conducted and data collected in compliance with prescribed and/or standard procedures and when deviations are required, justification will be documented.
- g. All data will be recorded and processed in a timely fashion.
- h. Only properly trained and qualified personnel will participate in the conduct of the test.

15. TOP 7-3-530, Vulnerability and Security (Aviation Materiel).

16. TOP 7-3-500, Physical Characteristics (Aviation Materiel).



i. The internal/external lighting equipment flight test will be conducted in a test environment representative of the operational environment intended for the materiel use.

j. Each test run will be conducted under documented conditions, such that the test results could be duplicated or compared.

k. The detailed test plan will be followed, deviations from same will be documented.

## 5. PERFORMANCE TEST.

a. The experience and qualifications of test personnel will be recorded on the data forms provided at Appendix C. This record of test personnel data will be utilized to assess the experience and qualifications of personnel assigned to participate in the test. Each key individual will be assigned an identification letter in parenthesis which will tag their contributions in completing any qualitative assessment required in the data collection and presentation. Individual names will not be presented in the test report in order to preserve individual privacy.

b. The conduct of the development test will be performed in compliance with the TECOM Test Design Plan reflected through the detailed test plan. However, if specific guidance is not available in the Test Design Plan, the test plan will reflect the following criteria and methodology to conduct the developmental performance test of the internal/external lighting equipment.

### 5.1 Illumination Criteria.

a. All light systems will perform according to applicable military lighting standards and the latest aeronautical design standards and/or the system specifications. The capability to operate a light system throughout the entire mission envelope, during day and night flight operations, is required. Further, there should be no degradation of flight performance because of internal reflections, glare, or lack of lighting uniformity. All lighting will meet the requirements of the Improved Lighting Systems for Army Aircraft (ILSAA), Letter Requirement (TRADOC ACN 32840),<sup>17</sup> which was approved by TRADOC and DARCOM. This includes the requirement that all internal lighting as well as the external formation lights be dimmable to a low enough level to be compatible with the use of a night vision system. Internal lighting should not provide undue ground signature while being operated in the normal flight mode.

17. Letter Requirement, TRADOC ACN 32840, Improved Lighting Systems for Army Aircraft.

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b. Caution,<sup>19</sup> warning, and status lights will conform to MIL-STD-411<sup>18</sup> and MIL-S-38039<sup>19</sup> or the latest aeronautical design standards. In order to be compatible with the use of night vision system, warning lights will be dimmable to a fixed level of approximately  $10^{-3}$  fL, and caution lights will be dimmable to a fixed level of approximately  $10^{-4}$  fL.

c. Instruments, dials, and switches will be balanced (both between and within instruments) for brightness and integrally illuminated in accordance with MIL-L-25467D.<sup>20</sup> Glass covers of instruments will be coated with anti-reflection coating in accordance with MIL-C-14806.<sup>21</sup> Dial and indicia brightness will be continuously dimmable down to  $10^{-6}$  fL in order to be compatible with the use of night vision systems.

d.<sup>22</sup> Information panels will be illuminated in accordance with MIL-P-7788<sup>22</sup> and will be continuously dimmable down to  $10^{-6}$  fL.

e. The chromaticity of all instrument, warning, and caution lights will conform to MIL-C-25050.<sup>23</sup>

f. Electro-optical panel mounted displays will maintain appropriate contrast and will be adjustable to the appropriate brightness levels for daytime, nighttime, and night vision systems use.

g. Miscellaneous lights such as LED readouts and the so-called bug lights will be dimmable to a level compatible with the use of night vision systems.

18. MIL-STD-411, Aircrew Station Visual Signals.

19. MIL-S-38039, Systems, Illuminated, Warning, Caution and Advisory, General Specification for.

20. MIL-L-25467, Lighting, Integral, Red, Aircraft Instrument, General Specification for.

21. MIL-C-14806, Coating Reflection Reduction for Instrument Cover Glasses and Lighting Wedges.

22. MIL-P-7788, Panel Information, Integrally Illuminated.

23. MIL-C-25050, Color, Aeronautical Lights and Lighting Equipment, General Requirements for.

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h. Standard lighting will include:

(1) An interior adjustable intensity lighting system to include a high intensity lighting system and other devices as required to minimize flash blindness effects of electrical storms.

(2) Auxiliary compartment light (white) sufficient to allow night inspections. This light must operate while the battery switch is in the off position.

(3) Formation (station keeping) lights with controllable intensity designed to prevent visual detection from the ground and crew disorientation (vertigo). Formation lights will be designed to conform to MIL-L-6503<sup>24</sup> and/or MIL-L-006730,<sup>25</sup> as specified in the system specifications.

(4) Navigation lights, high intensity flash tube day and night anti-collision lights, stowable landing light(s), and a searchlight controllable from pilot, copilot, and any other applicable crew station. A searchlight must be capable of 360° search. Reflection into the cockpit from these external lights will be minimal. Landing light(s) and searchlight(s) must be capable of operating in a stowed position without damage from<sup>26</sup> overheating. These<sup>27</sup> lights will meet the requirements of MIL-L-6503 and/or MIL-L-006730,<sup>27</sup> as specified in the system specifications.

(5) A map reading light will operate in accordance with MIL-L-6503.<sup>28</sup>

24. MIL-L-6503, Lighting Equipment, Aircraft, General Specification for, Installation of.

25. MIL-L-006730, Lighting Equipment; Exterior, Aircraft (General Requirements for).

26. MIL-L-6503, Lighting Equipment, Aircraft, General Specification for, Installation of.

27. MIL-L-006730, Lighting Equipment; Exterior, Aircraft (General Requirements for).

28. MIL-L-6503, Lighting Equipment, Aircraft, General Specification for, Installation of.



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i. Non-functional portions of the cockpit interior will have a reflectance value of less than 0.10. A low reflective black paint (MIL-L-46159)<sup>29</sup> could be used for this.

j. The lighting will be designed to minimize the ground signature of the aircraft lighting.

#### 5.2 Test Methodology.

a. In the interest of good testing practice and cost effectiveness, compatible materiel subtests will be conducted concurrently whenever possible so that possible interrelated problems can be identified and minimum data collection time can be effected. This section covers the procedures for accomplishing the performance subtest presented in paragraph 3.2.e.

b. The operational performance of the internal/external lighting equipment will be evaluated during all applicable flight modes and assessed under all applicable climatic and atmospheric conditions the aircraft is expected to encounter in its operational theater. The evaluation will cover both day and night operations under normal and emergency conditions as applicable. The internal/external lighting equipment will be operated and evaluated using all lighting options inherent to the aircraft and the developmental lighting equipment.

5.3 Internal. Evaluation of an internal lighting system or special internal light requires a quantitative and qualitative assessment of the illumination characteristics and intensity of the lighting equipment and the overall integrated lighting effect on the cockpit environment. The evaluation should be made under daylight and night conditions with special emphasis given to night vision equipment compatibility. It should be noted that light shielding devices and anti-reflectant coating on reflecting surfaces are an integral part of a lighting system.

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29. MIL-L-46159, Lacquer, Acrylic Low Reflective, Olive Drab.



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5.3.1 Method. Develop the set of possible operational modes and lighting combination options for both normal and emergency operations and/or situations which can occur. Switch methodically through the set of lighting options and vary the intensity, as applicable, of the developmental light or lighting system and evaluate each lighting setup. Repeat the procedure during all applicable flight modes and assess the performance under all applicable atmospheric and day/night conditions.

5.3.2 Data Required. Complete as appropriate the data collection form presented in Appendix B. Make a qualitative assessment reflecting the following parameters:

- a. Glare and/or reflections.
- b. Adequacy of lighting/effectiveness.
- c. Brightness.
- d. Total illumination effect.
- e. Compatibility with night vision equipment.
- f. Any fatigue inducing characteristic.
- g. Balance between instruments.
- h. Balance within instruments.
- i. Ease of operation.

5.4 External. Evaluation of an external lighting system or special purpose external light requires a quantitative and qualitative assessment of the illumination characteristics and intensity of the developmental lighting equipment and the overall integrated lighting effect on the aircraft environment. The evaluation should be made under daylight and night conditions with special emphasis given to night vision equipment compatibility. Develop the set of possible operational modes and lighting combinations for both normal and emergency operations and/or situations which can occur. Evaluate each lighting setup for all applicable flight modes and assess the

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performance under all applicable atmospheric conditions. Coordinate with air traffic control a detailed flight plan which includes a ground taxi to a location at least 5,000 feet from the airfield control tower, traffic pattern flights and direct over-flights of the control tower at altitudes up to 5,000 feet AGL.

5.4.1 Ground Evaluation.

5.4.1.1 Method (From the Test Aircraft). Taxi the test aircraft in the vicinity of the ramp where extraneous lighting exists and along a remote taxiway where maximum darkness exists.

5.4.1.1.1 Data Required. Evaluate the effectiveness of the ground operational performance of the developmental exterior light or lighting system. Make a qualitative assessment reflecting the following parameters and complete the applicable portions of the data collection form presented in Appendix B.

- a. Lighting effectiveness.
- b. Intensity.
- c. Any undesirable characteristics.
- d. Atmospheric conditions.

5.4.1.2 Method (From the Control Tower). As applicable, at the ramp in the proximity of the control tower and at the taxi location (minimum 5,000 feet from the control tower), taxi the aircraft in four major clover-leaf directions of ninety degree variations. Taxi directly toward the control tower to initiate the system of taxi directions.

5.4.1.2.1 Data Required. Have the air traffic controller or observer in the control tower evaluate the effectiveness of the ground operation performance of the external light or lighting system. From the controller standpoint, make a qualitative assessment reflecting the following parameters:

- a. Lighting effectiveness.

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- b. Intensity.
- c. Determination of aircraft direction of travel due to lighting arrangement and color code.
- d. Any undesirable characteristics.
- e. Atmospheric conditions.

5.4.1.3 Method (Evaluation From a Chase Aircraft). If applicable, orbit a chase aircraft in a left hand traffic pattern 1,000 feet AGL during the taxi maneuvers.

5.4.1.3.1 Data Required. Have the pilot and/or observer in the chase aircraft qualitatively evaluate the taxi maneuvers reflecting the following parameters:

- a. Lighting effectiveness.
- b. Intensity.
- c. Determination of aircraft direction of travel due to lighting arrangement and color code.
- d. Any undesirable characteristics.
- e. Atmospheric conditions as related to visibility characteristics, to include rain, snow, fog, dust, haze, etc.

5.4.2 Transition Flight (Take-off/Landings).

5.4.2.1 Method (Evaluation From the Test Aircraft). As applicable, evaluate the effectiveness of the developmental external light or lighting system under normal and emergency take-off and landing profiles.

5.4.2.1.1 Data Required. Complete as appropriate the data collection form presented in Appendix B. Have the pilot and/or qualified observer qualitatively evaluate the effectiveness of the developmental external light or lighting system reflecting the following parameters:

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- a. Glare and/or reflections.
- b. Adequacy of lighting (effectiveness).
- c. Directional control as applicable.
- d. Total illumination effect.
- e. Compatibility with night vision equipment.
- f. Ease of operation.
- g. Any distracting or fatigue inducing characteristics.
- h. Atmospheric conditions.

5.4.2.2 Method (Evaluation From the Control Tower). As applicable, evaluate the effectiveness of the external light or lighting system as an aid to the controller in maintaining aircraft separation as well as visual verification of the test aircraft's departure or landing flight path.

5.4.2.2.1 Data Required. Make a qualitative assessment of the effectiveness of the external light or lighting system from the controller standpoint reflecting the following parameters:

- a. Lighting effectiveness.
- b. Intensity.
- c. Determination of aircraft direction of travel due to lighting arrangement and color code.
- d. Any undesirable characteristics.
- e. Atmospheric conditions.



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5.4.2.3 Method (Evaluation From the Chase Aircraft). As applicable, orbit the chase aircraft in the traffic pattern at approximately 1,500 feet AGL and observe the test aircraft executing the take-off and landing maneuvers not to exceed 1,000 feet AGL (to insure a safe altitude separation). Assess the effectiveness of the developmental external light or lighting system to aid the airborne aircraft in spotting the test aircraft and maintaining aircraft separation and to visually verify the flight path of the test aircraft.

5.4.2.3.1 Data Required. Have the pilot or qualified observer make a qualitative assessment of the effectiveness of the external light or lighting system from the chase aircraft, reflecting the following parameters:

- a. Lighting effectiveness.
- b. Intensity.
- c. Determination of aircraft direction of travel due to lighting arrangement and color code.
- d. Any undesirable characteristics.
- e. Atmospheric conditions.

5.4.3 Airport Traffic Pattern Evaluation.

5.4.3.1 Method (Evaluation From the Control Tower). If applicable, orbit the test aircraft in a left and right hand traffic pattern, remaining approximately 1,000 feet AGL under normal and appropriate simulated emergency conditions.

5.4.3.1.1 Data Required. Have the controller or qualified observer observe the test aircraft from the control tower and qualitatively evaluate

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the developmental external light or lighting system, reflecting the following parameters:

- a. Lighting effectiveness.
- b. Intensity.
- c. Determination of aircraft direction of travel due to lighting arrangement and color code.
- d. Any undesirable characteristics.
- e. Atmospheric conditions.

5.4.3.2 Method (Evaluation From the Chase Aircraft). If applicable, have the chase aircraft approach the traffic pattern at a 45 degree angle to the downwind and upwind leg of the traffic pattern from above, below and in plane with the traffic pattern altitude (1,000 feet AGL) maintaining a safe horizontal or vertical aircraft separation.

5.4.3.2.1 Data Required. Have the pilot and/or qualified observer in the chase aircraft qualitatively evaluate the developmental external light or lighting system reflecting the following parameters:

- a. Lighting effectiveness.
- b. Intensity.
- c. Determination of aircraft direction of travel due to lighting arrangement and color code.
- d. Any undesirable characteristics.
- e. Atmospheric conditions.

5.4.4 In-Flight Evaluation.

5.4.4.1 Method (Evaluation From the Test Aircraft). As appropriate, evaluate the performance of the developmental external light or lighting system for all appropriate flight profiles. Give special consideration to NOE flights and night vision equipment compatibility.

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5.4.4.1.1 Data Required. Have the pilot or qualified observer make a qualitative assessment of the external light or lighting system and complete as applicable the data collection form presented in Appendix B. Make a qualitative evaluation reflecting the following parameters:

- a. Glare and/or reflections.
- b. Adequacy of lighting (effectiveness).
- c. Directional control (if applicable).
- d. Total illumination effect.
- e. Compatibility with night vision equipment.
- f. Ease of operation.
- g. Any distracting or fatiguing characteristics.
- h. Atmospheric conditions.

5.4.4.2 Method (Evaluation From the Control Tower). As applicable, establish radio communication and radar contact with the control tower if possible. Fly the test aircraft directly toward and away from the control tower. Have the control tower observe the test aircraft and advise when the developmental light or lighting system becomes visible or is lost to visual sight. Determine position of aircraft and maximum distance developmental lights are visible. If applicable, make three passes with lighting controls set for high ground visibility and three passes with controls set for low ground visibility in an attempt to determine the susceptibility of the lighting system to ground observation.

5.4.4.2.1 Data Required. Record the pertinent parameters (time, air-speed, altitude, local wind conditions) to determine the distance, from the control tower, when the developmental light or lighting system becomes visible and is lost to visual sight. Qualitatively assess the effectiveness of the developmental exterior light or lighting system, reflecting the following parameters:



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- a. Lighting effectiveness.
- b. Intensity.
- c. Determination of aircraft direction of travel due to lighting arrangement and color code.
- d. Visibility, at high and low ground visibility settings.
- e. Any undesirable characteristics.
- f. Atmospheric conditions.

5.4.4.3 Method (Evaluation From the Chase Aircraft). As applicable, have the chase aircraft remain in radio contact with the test aircraft and fly parallel to the test aircraft during the control tower evaluation phases, assuming each position an aircraft might feasibly occupy in formation flight with the test aircraft. Have the chase aircraft and test aircraft fly toward each other in the same vertical plane. Make two passes: Pass one, have the chase aircraft approximately 500 feet vertical separation above the test aircraft; Pass two, position the chase aircraft approximately 500 feet below the test aircraft.

5.4.4.3.1 Data Required. Qualitatively assess the effectiveness of the developmental exterior light or lighting system, reflecting the following parameters:

- a. Lighting effectiveness (formation flight).
- b. Intensity (at high and low ground visibility settings).
- c. Determination of the aircraft direction of travel due to lighting arrangement and color code.
- d. Any undesirable characteristics.
- e. Atmospheric conditions.

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6. DATA REDUCTION AND PRESENTATION.

a. The total data gathered in support of the subtest objectives presented in paragraphs 3.2 (a-j) will be analyzed to determine how well the developmental light or lighting system under test meets the test criteria and test objective established in the detailed test plan. In the instance of a total or partial failure of the external light/lighting system to perform its intended function, assess the broad implications of the failure to the developmental equipment itself and to the operational mission objective.

b. Summarize the test results and present any instance where the developmental light or lighting system fails to meet the test criteria or design objectives.

c. Present any test peculiar incident that may have occurred which could qualify the interpretation or use of the data presented.

d. Provide, when possible, recommendations for solutions to any problems encountered.

Recommended changes to this publication should be forwarded to Commander, US Army Test and Evaluation Command, ATTN: DRSTE-AD-M, Aberdeen Proving Ground, MD 21005. Technical information may be obtained from the preparing activity: Commander, US Army Aircraft Development Test Activity, ATTN: STEBG-PD-M, Fort Rucker, AL 36362. Additional copies are available from the Defense Documentation Center, Cameron Station, Alexandria, VA 22314. This document is identified by the accession number (AD No.) printed on the first page.

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APPENDIX A  
CHECKLIST

Internal/External Lighting  
(Aviation Materiel)

	YES	NO
1. Has developmental testing been completed in accordance with the appropriate TOP presented for each subtest presented in paragraph 3.2(a-j)?		
2. Were all test objectives presented in paragraph 3.2(a-j) addressed and, if not accomplished, adequately explained?		
3. Were the test facilities and other accommodations and support equipment sufficient to accomplish the test?		
4. Were the test results compromised in any way due to insufficient test preparation?		
5. Were the test results compromised in any way due to test control procedures?		
6. Were the test results compromised in any way due to performance test procedures?		
7. Were the test results compromised in any way due to data gathering, reduction or presentation techniques?		
8. Have any test peculiar incidents been reported which could qualify the interpretation or use of the data collected?		



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9. Have all data collected been reviewed for correctness and completeness?
10. Have performance data been collected, recorded and presented in accordance with this TOP 7-3-527?
11. Have all data forms in Appendix B of all appropriate TOPs presented in paragraph 3.2(a-j) been completed and reviewed for inclusion into the final test report?

YES	NO

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APPENDIX B  
Data Collection Form

Internal/External Lighting  
(Aviation Materiel)

I. Lighting Controls:

a. Is the off position in the extreme counterclockwise position for rotary controls? \_\_\_\_\_

b. For lights with variable intensity control, are the brightness variations uniform over the full brightness range? \_\_\_\_\_

c. For lights with dimmer control, record the brightness level at full bright position and the maximum dim position at the extreme counterclockwise position before "off." \_\_\_\_\_

\_\_\_\_\_

d. Are lighting controls within easy reach of the intended operator?

II. Internal Lighting:

a. Secondary Lighting: Illumination measurements shall be recorded in accordance with lighting location and description presented in Table V, MIL-L-6503H, Level of Illumination for Secondary Lighting.<sup>30</sup>

b. Cockpit Lighting:

(1) Is the general overall lighting in the cockpit sufficient to enable fast and accurate reading of all information contained on the control panels for all day or night flying conditions? \_\_\_\_\_

30. MIL-L-6503H, Lighting Equipment, Aircraft, General Specification for, Installation of.

NOTE: Place personnel identification code from Appendix C., by each response to the Data Collection Form, this Appendix, as appropriate.

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(2) Are all instrument readouts or dials sufficiently illuminated to enable fast and accurate readings for all day or night flying conditions? \_\_\_\_\_

(3) Are lights adequately located or shielded to prevent undesirable glare or reflections in the cockpit? \_\_\_\_\_

(4) Are all potential reflectant surfaces adequately coated with a non-reflectant material? \_\_\_\_\_

(5) Are all instruments, dials and switches integrally lighted? \_\_\_\_\_  
Describe any exceptions. \_\_\_\_\_

(6) Are all lighted instruments, dials and switches balanced (both between and within instruments) for brightness to enhance maximum eye comfort and fast and accurate readings? \_\_\_\_\_. Record any exceptions. \_\_\_\_\_

(7) Record the luminance value of all lighted instruments, dials and switches. \_\_\_\_\_

(8) Record any deleterious effect of a light or lighting system on the pilot or crew. \_\_\_\_\_  
Pay particular attention to night vision and topography scanning. \_\_\_\_\_

(9) Record the reflectance value for all nonfunctional portions of the cockpit interior, as appropriate. \_\_\_\_\_

(10) Record the luminance value and chromaticity of all information, caution and warning lights. \_\_\_\_\_



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## III. External Lights:

## a. Position Lights:

(1) Complete a position light intensity and dihedral angle table in accordance with MIL-L-6503H, Table VII, Light Intensities.<sup>31</sup>

(2) Record the chromaticity of each position light (red, green, white). \_\_\_\_\_

(3) Is position light shielding adequate to insure no deleterious effects on the pilot or crew? \_\_\_\_\_

## b. Anti-collision Lights:

(1) Record the field of coverage including 0-359° of test aircraft nose; (a) 500 feet above horizontal plane of test aircraft wings; (b) In plane with test aircraft wings, 500 feet below horizontal plane of test aircraft wings.

(2) Is the location and shielding adequate to insure no deleterious effect on the pilot or crew? \_\_\_\_\_

(3) Record the flashing characteristics. \_\_\_\_\_

(4) Record the light intensity. \_\_\_\_\_

(5) Record the chromaticity. \_\_\_\_\_

31. Ibid.

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c. Fuselage Lights:

- (1) Record location, color and chromaticity of each fuselage light.

\_\_\_\_\_  
\_\_\_\_\_.

- (2) Record the intensity above and below the horizontal plane of the test aircraft wings. \_\_\_\_\_

\_\_\_\_\_.

- (3) Is the fuselage light's location and/or shielding adequate to insure no deleterious effect on the pilot crew? \_\_\_\_\_

- (4) Is the fuselage light compatible with night vision equipment? \_\_\_\_\_

d. Landing and Taxiing Lights:

- (1) Are the landing and taxiing lights a multiple bulb system? \_\_\_\_\_

- (2) Is replacement of bulbs readily accomplished? \_\_\_\_\_

- (3) Are the lights located and/or shielded adequately to insure no deleterious effects on the pilot or crew? \_\_\_\_\_

- (4) Are the lights located as forward as practical? \_\_\_\_\_

- (5) Are the lights positioned to provide good ground reference for the pilot in all phases of landing and taxiing flight modes? \_\_\_\_\_

- (6) Record illumination measurements at 100 feet increments up to 500 feet in front of the aircraft with the aircraft in the final normal landing attitude. \_\_\_\_\_

\_\_\_\_\_.

- (7) Record illumination measurements in normal taxiing configuration at 100 feet increments, up to 500 feet, in front of the aircraft. \_\_\_\_\_

\_\_\_\_\_.

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(8) Record the chromaticity of the landing and taxiing lights. \_\_\_\_\_

(9) For landing lights which extend or retract, record the angle of travel above and below the normal level flight position. \_\_\_\_\_

e. Searchlight:

(1) Record the intensity. \_\_\_\_\_

(2) Record the chromaticity. \_\_\_\_\_

(3) Describe the operating characteristics and record the half cone angle and degrees of freedom for search operations. \_\_\_\_\_

f. Formation Lights:

(1) Are formation lights electro-illuminant? \_\_\_\_\_

(2) Record the chromaticity of the formation lights. \_\_\_\_\_

(3) Record the illuminated area produced by the lights over the full range of intensity. \_\_\_\_\_

(4) Describe the effectiveness of the lights to visually determine the altitude and position of a lead aircraft. \_\_\_\_\_

g. Emergency Lighting:

(1) Is emergency lighting in sufficient numbers and adequate brightness to permit crew and passengers to quickly evacuate an aircraft in the event of an accident? \_\_\_\_\_



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(2) Record the lighting intensity of the emergency lighting system in all compartments where crew or passengers might be located. \_\_\_\_\_

(3) Does the emergency lighting system have automatic and manual activation? \_\_\_\_\_

(4) Does the emergency lighting system have an independent self-contained power source? \_\_\_\_\_. Record the time in minutes that effective illumination will be provided upon activation. \_\_\_\_\_

h. Advisory, Caution and Warning Lights:

(1) Does the color and chromaticity and intensity of advisory, caution and warning lights comply with the requirements presented in MIL-STD-411?<sup>32</sup> \_\_\_\_\_

(2) Do lighted warning legends comply with the requirements established in MIL-STD-411?<sup>33</sup> \_\_\_\_\_

(3) When not energized, do the legends appear energized in direct sunlight? \_\_\_\_\_

(4) When not energized, are the legends readable? \_\_\_\_\_

(5) Do the operating characteristics comply with the operating criteria established in MIL-STD-411?<sup>34</sup> \_\_\_\_\_

(6) Does the location of advisory, caution and warning lights comply with MIL-STD-411?<sup>35</sup> \_\_\_\_\_

32. MIL-STD-411, Aircrew Station Visual Signals.

33. Ibid.

34. Ibid.

35. Ibid.

**INTERNAL/EXTERNAL LIGHTING (AVIATION MATERIEL)**

NOTES:

- (1) As applicable; e.g., pilot/operator/observer.
- (2) With correction, as applicable.